Pupils should be taught to:

Use units of measurement to measure, estimate, calculate and solve problems in a range of contexts; convert between metric units and know rough metric equivalents of common imperial measures

As outcomes, Year 7 pupils should, for example:

Use, read and write, spelling correctly, names and abbreviations of:

Standard metric units
- millimetre (mm), centimetre (cm), metre (m), kilometre (km)
- gram (g), kilogram (kg)
- millilitre (ml), centilitre (cl), litre (l)
- square millimetre (mm^2), square centimetre (cm^2), square metre (m^2), square kilometre (km^2)

Units of temperature, time, angle
- degree Celsius (°C)
- second (s), minute (min), hour (h), day, week, month, year, decade, century, millennium
- degree (°)

Know relationships between units of a particular measure, e.g.
- 1 kg = 1000 g

See Y456 examples (pages 90–1).

Convert between one metric unit and another.

Know the relationship between metric units in common use and how they are derived from the decimal system. For example:

1000	100	10	1	0.1	0.01	0.001
km	–	–	m	–	cm	mm
8	0	0	0			
			4			
				3	7	
				2	3	0

8000 m = 8 km
4 m = 400 cm = 4000 mm
37 cm = 0.37 m
230 mm = 0.23 m

Understand that for the same measurement in two different units:
- if the unit is smaller, the number of units will be greater;
- if the unit is bigger, the number of units will be smaller.

Change a larger unit to a smaller one. For example:
- Change 36 centilitres into millilitres.
- Change 0.89 km into metres.
- Change 0.56 litres into millilitres.

Change a smaller unit to a larger one. For example:
- Change 750 g into kilograms.
- Change 237 ml into litres.
- Change 3 cm into metres.
- Change 4 mm into centimetres.

Begin to know and use rough metric equivalents of imperial measures in daily use. For example, know that:
- 1 gallon ≈ 4.5 litres
- 1 pint is just over half a litre.

For example:
- A litre of petrol costs 89.9p.
  Approximately, how much would 1 gallon cost?

See Y456 examples (pages 90–1).

Link to mental recall of measurement facts (pages 90–1).

As outcomes, Year 8 pupils should, for example:

Continue to use familiar units of measurement from previous year and extend to:

Standard metric units
- tonne (not usually abbreviated)
- hectare (ha)
- cubic millimetre (mm^3), cubic centimetre (cm^3), cubic metre (m^3)

Commonly used imperial units
- ounce (oz), pound (lb), foot (ft), mile, pint, gallon

Know the relationships between the units of a particular measure, e.g.
- 1 hectare = 10 000 m^2
- 1 tonne = 1000 kg

and extend to:
- 1 litre = 1000 cm^3
- 1 millilitre =1 cm^3
- 1000 litres = 1 m^3

Convert between one unit and another.

Convert between area measures in simple cases. For example:
- A rectangular field measures 250 m by 200 m. What is its area in hectares (ha)?
- Each side of a square tablecloth measures 120 cm. Write its area in square metres (m^2).

Convert between units of time. For example:
- At what time of what day of what year will it be:
  a. 2000 minutes
  b. 2000 weeks
  after the start of the year 2000?
- How many seconds will pass before your next birthday?

Consolidate changing a smaller unit to a larger one. For example:
- Change 760 g into kilograms.
- Change 400 ml into litres.

Know rough metric equivalents of imperial measures in daily use (feet, miles, pounds, pints, gallons) and convert one to the other. For example, know that:

- 1 m ≈ 3 ft
- 8 km ≈ 5 miles
- 1 kg ≈ 2.2 lb and 1 ounce ≈ 30 g
- 1 litre is just less than 2 pints.

Link to mental recall of measurement facts (pages 90–1).

As outcomes, Year 9 pupils should, for example:

Continue to use familiar units of measurement from previous years *and extend to:*

Compound measures
- *average speed (distance/time)*
- *density (mass/volume)*
- *pressure (force/area)*

Convert between metric units, including area, volume and capacity measures.

For example:
- Change 45 000 square centimetres (cm^2) into square metres (m^2).
- Change 150 000 square metres (m^2) into hectares;
- Change 5.5 cubic centimetres (cm^3) into cubic millimetres (mm^3);
- Change 3.5 litres into cubic centimetres (cm^3).

Link to mental recall of measurement facts (pages 90–1).

Convert between currencies. For example:
- Use £1 = 10.6 rands to work out how much 45p is in rands.
- Use 565 drachmae = £1 to work out how much 1000 drachmae is in pounds.

Convert one rate to another. For example:
- *Convert 30 mph to metres per second.*

Link to direct proportion (pages 78–9) and conversion graphs (pages 172–3).

Pupils should be taught to:

Use units of measurement to measure, estimate, calculate and solve problems in a range of contexts; convert between metric units and know rough metric equivalents of common imperial measures (continued)

As outcomes, Year 7 pupils should, for example:

Use opportunities in science, design and technology, geography and other subjects to estimate and measure using a range of measuring instruments.

Suggest appropriate units and methods to estimate or measure length, area, capacity, mass and time. For example, estimate or suggest units to measure:

- the length of a football field… the thickness of a hair… the diameter of a CD…
- the area of the school hall… of a postage stamp… of the school grounds… the surface area of a matchbox…
- the mass of a coin… of a van…
- the time to run the length of a football field… to boil an egg… to mature a cheese… to travel to the moon…

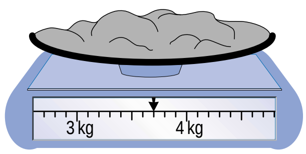
Give a suitable range for an estimated measurement.
For example, estimate that:

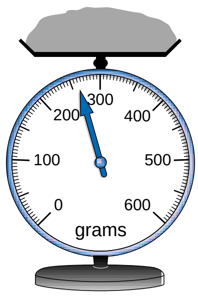
- 3 m < width of classroom window < 4m
- 0.5 litre < capacity of a tankard < 1 litre
- 50 g < mass of a golf ball < 1000 g

Check by measuring as precisely as possible whether the measurement lies within the estimated range.

Read and interpret scales on a range of measuring instruments, with appropriate accuracy, including:

- vertical scales, e.g. thermometer, tape measure, ruler, measuring cylinder…
- scales around a circle or semicircle, e.g. for measuring time, mass, angle…





See Y456 examples (pages 94–5).

Link to rounding (pages 42–5).

Solve problems involving length, area, capacity, mass, time and angle, rounding measurements to an appropriate degree of accuracy.

See Y456 examples (pages 86–93).

Link to problem solving (pages 18–21) and area (pages 234–7).

As outcomes, Year 8 pupils should, for example:

Use opportunities in other subjects to estimate and measure using a range of measuring instruments, particularly opportunities to measure volume and bearings.

Suggest appropriate units and methods to estimate or measure volume. For example, estimate or suggest units to measure:

- the volume of a matchbox, of a telephone box, of the school hall…

Estimate measures within a given range. Suggest approximate measures of objects or events to use as reference points or benchmarks for comparison. For example, the approximate:

- height of a door is 2 m;
- height of an average two-storey house is 10 m;
- mass of a large bag of sugar is 1 kg;
- mass of a small family car is about 1000 kg;
- capacity of a small tumbler is about 250 ml;
- area of a football pitch is 7500 m^2;
- area of a postcard is 100 cm^2;
- time to walk one mile is about 20 minutes.

Suggest and justify an appropriate degree of accuracy for a measurement. For example:

- John says he lives 400 metres from school. Do you think this measurement is correct to:
  A. the nearest centimetre,
  B. the nearest metre,
  C. the nearest 10 metres, or
  D. the nearest 100 metres?

  It takes John 7.5 minutes to walk to the school. Do you think this measurement is correct to:
  P. the nearest second,
  Q. the nearest 30 seconds, or
  R. the nearest minute?

Solve problems involving length, area, volume, capacity, mass, time, angle and bearings, rounding measurements to an appropriate degree of accuracy.

Link to problem solving (pages 18–21), area (pages 234–7), volume (pages 238–9), and bearings (pages 232–3).

As outcomes, Year 9 pupils should, for example:

Suggest appropriate units to estimate or measure speed. *For example, estimate or suggest units to measure the average speed of:*

- *an aeroplane flying to New York from London, a mountain climber, a rambler on a country walk, a swimmer in a race, a snail in motion, a jaguar chasing prey…*

Know that no measurement can be made exactly *so it is conventional to give any measured value to the nearest whole unit or decimal place (e.g. the nearest mark on a scale). A measurement may be in error by up to half a unit in either direction. For example:*

- *A length d m is given as 36 m. It is presumed to be to the nearest metre so* $35.5 \le d < 36.5$.
- *A volume V* cm^3 *is given as 240* cm^3*. It is presumed to be to the nearest 10* cm^3 *so* $235 \le V < 245$.
- *A mass m kg is given as 2.3 kg. It is presumed to be to the nearest 0.1 kg so* $2.25 \le m < 2.35$.

Suggest a range for measurements such as:

- *123 mm   1860 mm   3.54 kg   6800* m^2

Solve problems such as:

- *The dimensions of a rectangular floor, measured to the nearest metre, are given as 28 m by 16 m. What range must the area of the floor lie within? Suggest a sensible answer for the area, given the degree of accuracy of the data.*

Link to rounding and approximation (pages 42–7).

Solve problems involving length, area, volume, capacity, mass, time, speed, angle and bearings, rounding measurements to an appropriate degree of accuracy.

Link to problem solving (pages 18–21), area (pages 234–7), volume (pages 238–9), bearings (pages 232–3), and speed (pages 232–3).

Pupils should be taught to:

Extend the range of measures used to angle measure and bearings, and compound measures

As outcomes, Year 7 pupils should, for example:

Angle measure

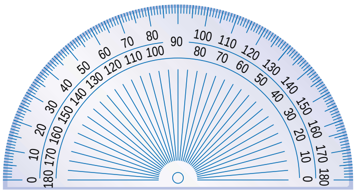
Use, read and write, spelling correctly:
angle, degree (°)… protractor (angle measurer), set square… right angle, acute angle, obtuse angle, reflex angle…

Use angle measure; distinguish between and estimate the size of acute, obtuse and reflex angles.

Discuss 'rays' of lines emanating from a point, using angles in degrees as a measure of turn from one ray to another.

Know that:
- An angle less than 90° is an acute angle.
- An angle between 90° and 180° is an obtuse angle.
- An angle between 180° and 360° is a reflex angle.
- An angle greater than 360° involves at least one complete turn.

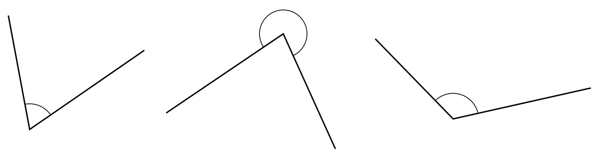
Use a 180° or 360° protractor to measure and draw angles, including reflex angles, to the nearest degree. Recognise that an angle can be measured as a clockwise or anticlockwise rotation and that the direction chosen determines which will be the zero line and whether the inner or outer scale is to be used.



- Draw angles of 36°, 162° and 245°.

Estimate acute, obtuse and reflex angles. For example:

- Decide whether these angles are acute, obtuse or reflex, estimate their size, then measure each of them to the nearest degree.



- Imagine a semicircle cut out of paper.
  Imagine folding it in half along its line of symmetry.
  Fold it in half again, and then once more.
  How many degrees is the angle at the corner of the shape now?

Link to angles and lines (pages 178–83), and construction (pages 220–3).

As outcomes, Year 8 pupils should, for example:

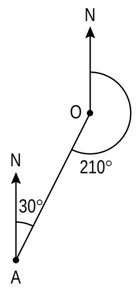
Bearings

Use, read and write, spelling correctly:
bearing, three-figure bearing…
and compass directions.

Use bearings to specify direction and solve problems, including making simple scale drawings.

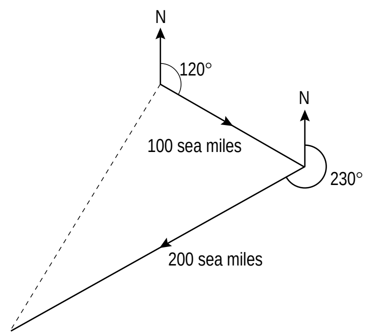
Know that the bearing of a point A from an observer O is the angle between the line OA and the north line through O, measured in a clockwise direction.

In the diagram the bearing of A from O is 210°.
The three-figure bearing of O from A is 030°.



For example:

- If the bearing of P from Q is 045°, what is the bearing of Q from P?
- If the bearing of X from Y is 120°, what is the bearing of Y from X?
- A ship travels on a bearing of 120° for 100 sea miles, then on a bearing of 230° for a further 200 sea miles. Represent this with a scale drawing. What is the ship's distance and bearing from the starting point?



Link to angles and lines (pages 178–83), and scale drawings (pages 216–17).

As outcomes, Year 9 pupils should, for example:

Compound measures

Use, read and write, spelling correctly:
speed, density, pressure… and units such as:
miles per hour (mph), metres per second (m/s).

Understand that:

- ***Rate** is a way of comparing how one quantity changes with another, e.g. a car's fuel consumption measured in miles per gallon or litres per 100 km.*
- *The two quantities are usually measured in different units, and 'per', the abbreviation 'p' or an oblique '/' is used to mean 'for every' or 'in every'.*

*Know that if a rate is **constant** (uniform), then the two variables are in direct proportion and are connected by a simple formula. For example:*

- ***speed*** $= \dfrac{\text{distance travelled}}{\text{time taken}}$
- ***density*** $= \dfrac{\text{mass of object}}{\text{volume of object}}$
- ***pressure*** $= \dfrac{\text{force on surface}}{\text{surface area}}$

*Know that if a rate varies, the same formula can be used to calculate an **average rate**. For example:*

- *A cyclist travels 36 miles in 3 hours.*
  *Her **average speed** is 12 mph.*

Solve problems involving average rates of change.
For example:

- *The distance from London to Leeds is 190 miles. An Intercity train takes about 2¼ hours to travel from London to Leeds. What is its average speed?*
- *a. A cyclist travels 133 km in 8 hours, including a 1 hour stop. What is her average cycling speed?*
  b. She cycles for 3 hours on the flat at 20 km/h and 1½ hours uphill at 12 km/h. What is her total journey time?
  c. The cyclist travels 160 km at an average speed of 24 km/h. How long does the journey take?
- *Naismith's rule, used by mountain walkers, says that you should allow 1 hour for every 3 miles travelled and ½ hour for each 1000 ft climbed. At what time would you expect to return from a walk starting at 09:00, if the distance is 14 miles and 5000 feet have to be climbed, allowing an extra 2 hours for stops and possible delays?*

Use speed, density and pressure in other subjects, such as science or physical education.

Link to formulae and direct proportion in algebra (pages 136–7), and distance–time graphs (pages 172–7).

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:

Deduce and use formulae to calculate lengths, perimeters, areas and volumes in 2-D and 3-D shapes

Use, read and write, spelling correctly:
area, surface, surface area, perimeter, distance, edge…
and use the units: *square centimetre (cm^2), square metre (m^2), square millimetre (mm^2)…*

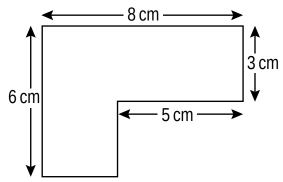
Deduce and use formulae for the perimeter and area of a rectangle.

Derive and use a formula for the area of a right-angled triangle, thinking of it as half a rectangle:

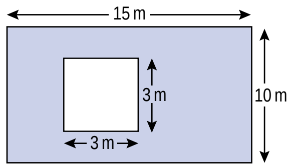
area = ½ × base length × height
area = ½*bh*

Calculate the perimeter and area of shapes made from rectangles. For example:

- Find the area of this shape.



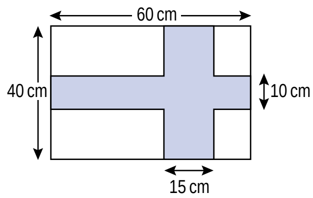
- Find the shaded area.



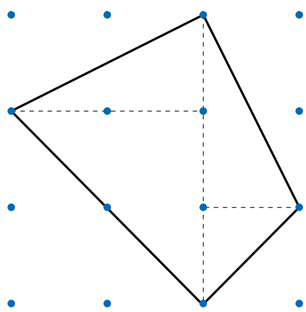
- Find the area and outside perimeter of a path 1 metre wide bordering a 5 metre square lawn.

- Here is a flag.

  Calculate the area of the shaded cross.



- Find the area of this quadrilateral:
  a. by completing the 3 by 3 square and subtracting the pieces outside the quadrilateral;
  b. by dissecting the inside of the quadrilateral into rectangles and/or right-angled triangles.

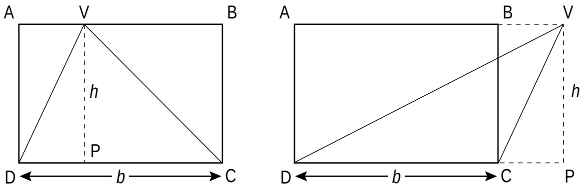


As outcomes, Year 8 pupils should, for example:

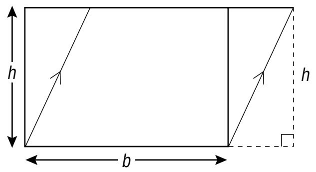
Use vocabulary from previous year and extend to:
volume, space, displacement...
and use the units: *hectare (ha), cubic centimetre (cm^3), cubic metre (m^3), cubic millimetre (mm^3)...*

Deduce formulae for the area of a parallelogram, triangle and trapezium. For example, explain why:

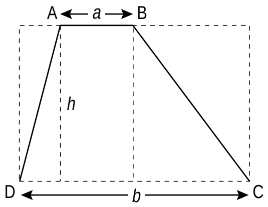
- The area of a triangle is given by $A = \frac{1}{2}bh$, where b is the base and h is the height of the triangle.



- A rectangle and parallelogram on the same base and between the same parallels have the same area, $A = bh$, where b is the base and h is the perpendicular distance between the parallels.

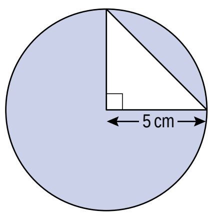


- The area of a trapezium, where h is the perpendicular distance between the parallel sides, is ½ (sum of parallel sides) × h.

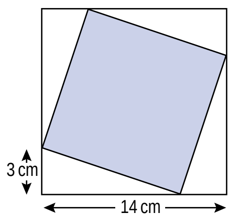


Calculate areas of triangles, parallelograms and trapezia, and of shapes made from rectangles and triangles. For example:

- A right-angled triangle lies inside a circle.
  The circle has a radius of 5 cm.
  Calculate the area of the triangle.



- The diagram shows a shaded square inside a larger square.
  Calculate the area of the shaded square.



As outcomes, Year 9 pupils should, for example:

Use vocabulary from previous years and extend to:
circumference, π...
and names of the parts of a circle.
Link to circles (pages 194–7).

Know and use the formula for the circumference of a circle. For example:

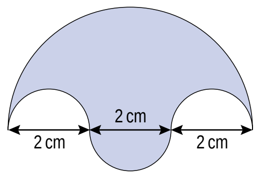
Know that the formula for the circumference of a circle is $C = \pi d$, or $C = 2\pi r$, and that different approximations to π are 3, $^{22}\!/_7$, or 3.14 correct to 2 d.p.

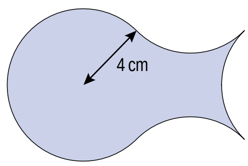
Use the π key on a **calculator**.

Calculate the circumference of circles *and arcs of circles.* For example:

- A circle has a circumference of 120 cm.
  What is the radius of the circle?
- The diameter of King Arthur's Round Table is 5.5 m.
  A book claims that 50 people sat round the table.
  Assume each person needs 45 cm round the circumference of the table.
  Is it possible for 50 people to sit around it?
- The large wheel on Wyn's wheelchair has a diameter of 60 cm.
  Wyn pushes the wheel round exactly once.
  Calculate how far Wyn has moved.

  The large wheel on Jay's wheelchair has a diameter of 52 cm.
  Jay moves her wheelchair forward 950 cm.
  How many times does the large wheel go round?
- A Ferris wheel has a diameter of 40 metres. How far do you travel in one revolution of the wheel?
- A touring cycle has wheels of diameter 70 cm.
  How many rotations does each wheel make for every 10 km travelled?
- *All curves in the left-hand figure are semicircles.*
  All curves in the right-hand figure are quarter circles or three-quarter circles.
  Calculate the perimeter of each shape.





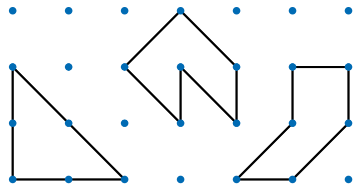
Know that the length of an arc is directly proportional to the size of the angle θ between the two bounding radii, or arc length = 2πr × θ/360, where θ is in degrees and r is the length of the radius.

Pupils should be taught to:

Deduce and use formulae to calculate lengths, perimeters, areas and volumes in 2-D and 3-D shapes (continued)

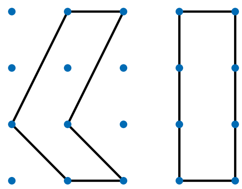
As outcomes, Year 7 pupils should, for example:

- Using a pinboard, make different shapes with an area of 2 square units.



Investigate relationships between perimeters and areas of different rectangles. For example:

- Sketch and label some shapes which have an area of 1 m^2. Find the perimeter of each shape.
- A rectangle has a fixed area of 36 cm^2. What could its perimeter be? What shape gives the smallest perimeter?
- A rectangle has a fixed perimeter of 20 cm. What could its area be? What shape encloses the most area?
- Do these shapes have:
  a. the same area?
  b. the same perimeter?

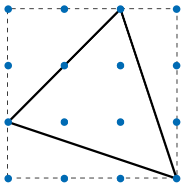
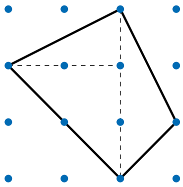


See Y456 examples (pages 96–7).

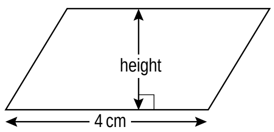
Link to problem solving (pages 18–19).

As outcomes, Year 8 pupils should, for example:

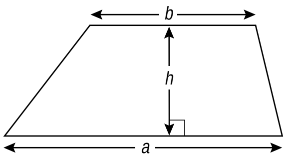
- On a 1 cm grid, draw a triangle with an area of 7.5 cm² and an obtuse angle.
- Use methods such as dissection or ‘boxing’ of shapes to calculate areas. For example:
  Draw these shapes on a 1 cm spotty grid and use the dashed lines to help find their areas.

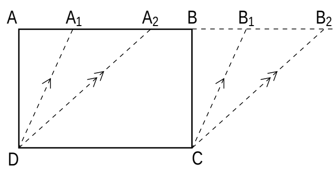
- Make quadrilaterals on a 3 by 3 pinboard.
  Find the area of each quadrilateral.
- The area of the parallelogram is 10 cm².
  Calculate the height of the parallelogram.

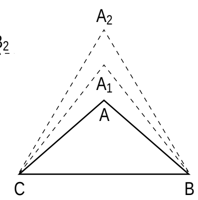


- The area of the trapezium is 10 cm².
  What might be the values of h, a and b ($a > b$)?



- Use a pinboard and spotty paper to investigate simple transformations of the vertices of triangles and parallelograms, and how they affect the area of the shapes. For example:





  Find the area of each parallelogram or triangle and explain what is happening.

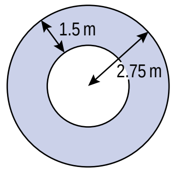
Link to problem solving (pages 18–19).

As outcomes, Year 9 pupils should, for example:

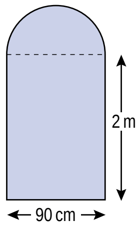
Know and use the formula for the area of a circle:
$A = \pi d^2/4$ or $A = \pi r^2$

For example:

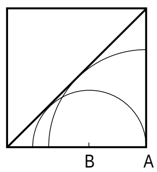
- A circle has a radius of 15 cm.
  What is its area?
- Calculate the area of the shaded shape.



- A church door is in the shape of a rectangle with a semicircular arch.
  The rectangular part is 2 m high and the door is 90 cm wide.
  What is the area of the door?



- Napoli Pizzas make two sizes of pizza.
  a. A small pizza has a diameter of 25 cm.
     What is the surface area of the top of the pizza?
  b. A large pizza has twice the surface area of the small one. What is the diameter of the large pizza?
  c. A small boy reckons he could just about manage to eat a 120° wedge (sector) of the large pizza. What is the area covered by topping on this piece?
- The inside lane of a running track is 400 m long, 100 m on each straight and 100 m on each semicircular end.
  What area in the middle is free for field sports?
- *A donkey grazes in a 60 m by 60 m square field with a diagonal footpath. The donkey is tethered to a post. It can just reach the path, but not cross it. Consider two tethering positions:*
  A. *corner A, making the largest possible quarter circle (quadrant) for the donkey to graze;*
  B. *point B, somewhere on the field boundary, making the largest possible semicircle.*



  Which tethering position gives the bigger grazing area? Use scale drawing and measurement to help calculate the answer.
  What if the field is rectangular?

Know that the area of a sector of a circle is directly proportional to the size of the angle θ between the two bounding radii, or area of sector = $2\pi r^2 \times \theta/360$, where θ is in degrees and r is the length of the radius.

Link to problem solving (pages 18–19).

Pupils should be taught to:

Deduce and use formulae to calculate lengths, perimeters, areas and volumes in 2-D and 3-D shapes (continued)

As outcomes, Year 7 pupils should, for example:

Find the surface area of cuboids and shapes made from cuboids. Check by measurement and calculation.

Unfold packets in the shape of cuboids and other 3-D shapes to form a net. Relate the surface area to the shape of the net.

Estimate the surface area of everyday objects. For example:

- Estimate the surface area of a house brick, a large cereal packet, a matchbox…
  Check estimates by measurement and calculation.

Derive and use a formula for the **surface area *S* of a cuboid** with length l, width w and height h:

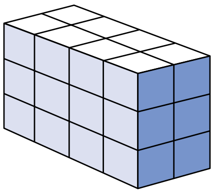
S = 2(length × width) + 2(length × height) + 2(height × width)
$S = 2lw + 2lh + 2hw$

As outcomes, Year 8 pupils should, for example:

Know the formula for the volume of a cuboid and use it to solve problems involving cuboids.

Understand the formula for the volume of a cuboid by considering how to count unit cubes.

- Suppose the cuboid is l units long, w units wide and h units high.



Then:
area of base = lw square units
volume = area of base × number of layers
= lwh cubic units

Estimate volumes. For example:

- Estimate the volume of everyday objects such as a rectangular chopping board, a bar of soap, a shoe box...
  Check estimates by measurement and calculation.

Suggest volumes to be measured in cm^3, m^3.

Volume and displacement
In science, start to appreciate the connection between volume and displacement. For example,

- Make some cubes or cuboids with different numbers of Centicubes.
  Put them into a measuring cylinder half filled with water. How many millilitres does the water rise?
  What is the connection between the volume of the cube or cuboid and the volume of water displaced?
  (1 ml of water has a volume of 1 cm^3.)

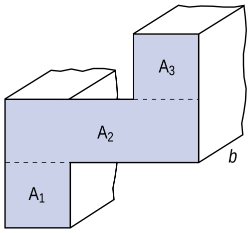
As outcomes, Year 9 pupils should, for example:

Calculate the surface area and volume of a right prism.

Know that a prism is a polyhedron of uniform cross-section throughout its length. A cuboid is a common example.

Use knowledge of prisms made up of cuboids to write an expression for the total volume of such a prism. For example:

- A prism has cross-section areas A_1, A_2, A_3, ..., all of length b.



$$V = A_1b + A_2b + A_3b + \ldots$$
$$= (A_1 + A_2 + A_3 + \ldots)\,b$$
$$= \text{total area of cross-section} \times \text{length}$$

Surface area and volume of a cylinder
Know that the total surface area A of a cylinder of height h and radius r is given by the formula
$A = 2\pi r^2 + 2\pi rh$
and that the volume V of the cylinder is given by the formula
$V = \pi r^2 h$

- *In geography, use a rain gauge, then estimate the volume of water which has fallen on a specified area over a given period.*

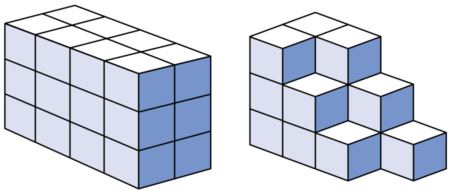
Pupils should be taught to:

Deduce and use formulae to calculate lengths, perimeters, areas and volumes in 2-D and 3-D shapes (continued)

As outcomes, Year 7 pupils should, for example:

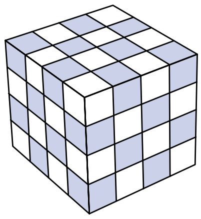
Solve simple problems such as:

- How many unit cubes are there in these shapes?
  What is the surface area of each shape?

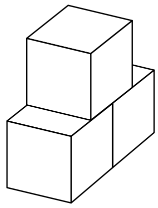


- Investigate the different cuboids you can make with 24 cubes. Do they all have the same surface area?

- This solid cube is made from alternate blue and white centimetre cubes.
  What is its surface area?
  How much of its surface area is blue?



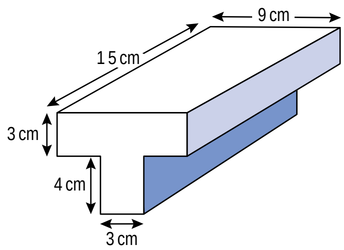
- This shape is made from three identical cubes.
  The top cube is placed centrally over the other two.



  The faces of the shape are to be covered in sticky paper.
  Sketch the different shapes of the pieces of paper required.
  Say how many of each shape are needed.

  If each cube has an edge of 5 cm, what is the surface area of the whole shape?
  Compare different methods of working this out.

- Calculate the surface area in cm^2 of this girder.



- 12 cubes with 1 cm edges are each covered in sticky paper. How much paper is needed?

  The 12 cubes are wrapped in a single parcel. What arrangement of the cubes would need the least paper?

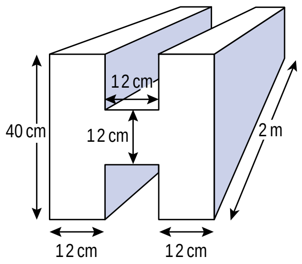
Link to lines, angles and shapes (pages 178–201), and problem solving (pages 18–19).

As outcomes, Year 8 pupils should, for example:

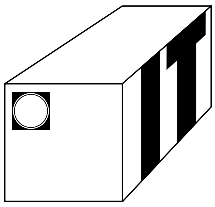
Solve problems such as:

- Find the volume of a 3 cm by 4 cm by 5 cm box.

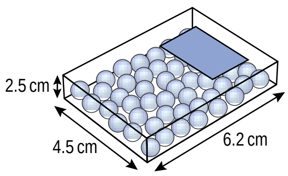
- Find the volume in cm^3 of this H-shaped girder by splitting it into cuboids.



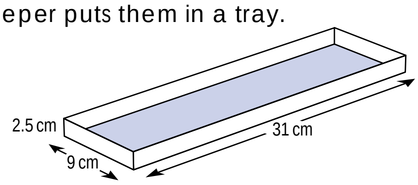
- Containers come in three lengths: 12 m, 9 m and 6 m. Each is 2.3 m wide and 2.3 m tall. How many crates measuring 1.1 m by 1.1 m by 2.9 m will fit in each of the three containers?



- Boxes measure 2.5 cm by 4.5 cm by 6.2 cm.

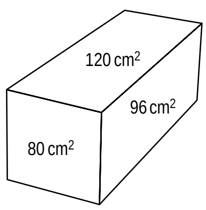


A shopkeeper puts them in a tray.

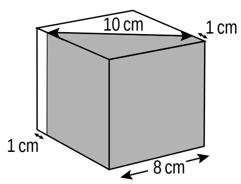


Work out the largest number of boxes that can lie flat in the tray.

- What is the total surface area of this box? Find the length of each edge.



- This block of cheese is in the shape of a cube. Each edge is 8 cm long. It is cut into two pieces with one vertical cut.



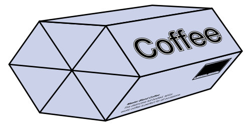
Calculate the volume and surface area of the shaded piece.

Link to lines, angles and shapes (pages 178–201), and problem solving (pages 18–19).

As outcomes, Year 9 pupils should, for example:

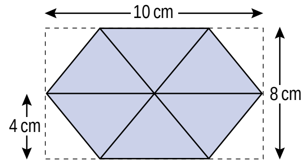
Solve problems such as:

- A box for coffee is in the shape of a hexagonal prism.



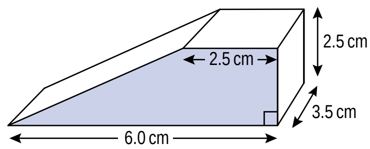
Each of the six triangles in the hexagon has the same dimensions.

Calculate the total area of the hexagon.



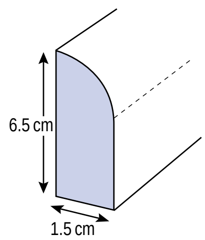
The box is 12 cm long.
After packing, the coffee fills 80% of the box.
How many grams of coffee are in the box?
(The mass of 1 cm^3 of coffee is 0.5 grams.)

- This door wedge is in the shape of a prism.



The shaded face is a trapezium.
Calculate its area.
Calculate the volume of the door wedge.

- *The cross-section of a skirting board is in the shape of a rectangle, with a quadrant (quarter circle) on top. The skirting board is 1.5 cm thick and 6.5 cm high. Lengths totalling 120 m are ordered. What volume of wood is contained in the order?*



- *Large wax candles are made in the shape of a cylinder of length 20 cm and diameter 8 cm. They are packed neatly into individual rectangular boxes in which they just fit.*
  What percentage of the space in each box will be occupied by air?
  If the dimensions of the candle and its box are doubled, what effect does this have on the percentage of air space?

- *A can in the shape of a cylinder is designed to have a volume of 1000 cm^3. The amount of metal used is to be a minimum. What should the height of the can and radius of the top be?*
  *Use a **spreadsheet** to help you.*

Link to lines, angles and shapes (pages 178–201), and problem solving (pages 18–19).

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Begin to use sine, cosine and tangent to solve problems	

As outcomes, Year 8 pupils should, for example:

As outcomes, Year 9 pupils should, for example:

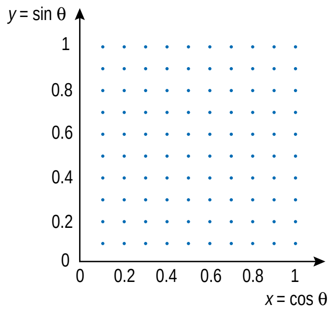
Use, read and write, spelling correctly:
sine (sin), cosine (cos), tangent (tan)…
opposite, adjacent, hypotenuse…
angle of elevation, angle of depression…

Begin to use sine, cosine and tangent to solve problems involving right-angled triangles in two dimensions. *For example:*

- *Use the SIN (sine) key and the COS (cosine) key on a **calculator** to complete this table. Round each value to two decimal places.*

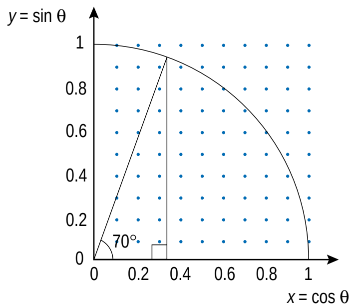
θ	cos θ	sin θ
0°		
10°		
20°		
30°		
40°		
50°		
60°		
70°		
80°		
90°		

Plot points on a graph, using cos θ for the x-coordinate and sin θ for the y-coordinate.

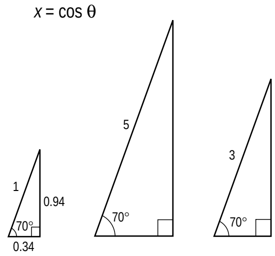


What do you notice about the graph and table?

- *Draw a right-angled triangle with an angle of 70° on the grid. The hypotenuse is of length 1. The lengths of the other two sides are given by cos 70° and sin 70° (or 0.34 and 0.94 respectively, correct to two decimal places).*



Use this information to write the lengths of the sides of the other two triangles.



- *Find the lengths of the sides of the triangles if the angle changes to 50°.*

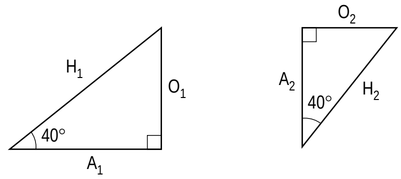
Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Begin to use sine, cosine and tangent to solve problems (continued)	

As outcomes, Year 8 pupils should, for example:

As outcomes, Year 9 pupils should, for example:

Consider sine, cosine and tangent as ratios.
For example:

- *Use a ruler and protractor to draw a variety of similar right-angled triangles, e.g. with an angle of 40°.*



Measure the hypotenuse H, the side A adjacent to the known angle, and the side O opposite to the known angle.

Use a ***spreadsheet*** *to explore the value of A/H.*

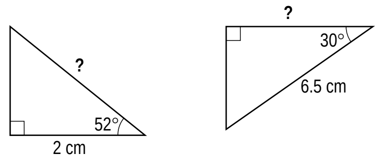
A (cm)	H (cm)	A/H
10.0	13.06	0.766
	4.5	0.766
6.0		0.766
	10.5	0.766
4.42		0.766

Conclude that for each triangle the approximate value of A/H is the same as the ***cosine*** *of the angle, or cos 40°.*

Similarly, know that the approximate value O/H is the ***sine*** *of the angle, or sin 40°, and that the approximate value O/A is the* ***tangent*** *of the angle, or tan 40°.*

For example:

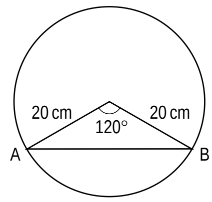
- *Find the sides marked with a question mark in triangles such as:*



Solve problems such as:

- *A girl is flying a kite. The string is 30 m long and is at an angle of 42° to the horizontal.*
  How high is the kite above the girl's hand?

- *A circle has a radius of 20 cm.*
  Calculate the length of the chord AB.

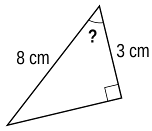


Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Begin to use sine, cosine and tangent to solve problems (continued)	

As outcomes, Year 8 pupils should, for example:

As outcomes, Year 9 pupils should, for example:

- *Use a **calculator** to find the value of an angle of a right-angled triangle, given two sides.*



For example:

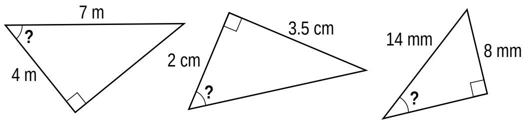
*The adjacent side is 3 cm and the hypotenuse is 8 cm. On a **scientific calculator** press, for example:*

[3] [÷] [8] [=] [INV] [COS] [=]

*On a **graphical calculator** press, for example:*

[SHIFT] [COS] [(] [3] [÷] [8] [)] [EXE]

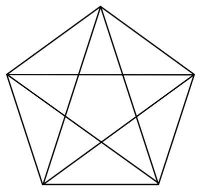
- *Find the angle marked with a question mark in triangles such as:*



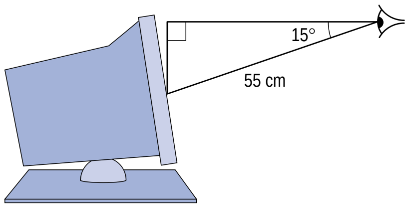
Solve problems such as:

- *A boy walks 6 km west and then 8 km north. How far is he now from his starting point? The boy wants to get back to his starting point by the shortest route. On what bearing should he walk?*

- *The sides of a regular pentagon are 12 cm long. Find the length of a diagonal.*



- *The most comfortable viewing distance from the eye direct to the centre of a computer screen is 55 cm, looking down from the horizontal at 15°.*



  a. *What height should your eyes be above the centre of the screen?*
  b. *How far away (horizontally) should you sit from the screen?*

- *What angle does the line $y = 2x - 1$ make with the x-axis?*

- *What is the angle of slope of a 1 in 5 (20%) hill?*

Link to Pythagoras' theorem (pages 186–9), similarity (pages 192–3), and gradient (pages 166–9).